

## Survey of Programs Related to Low Power Modes

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### Introduction

Many programs around the world deal with standby power and other low power modes<sup>2</sup>. The programs typically consist of one or more of the following features:

- Test procedures
- Certification
- Labels
- Mandatory regulations

For example, most ENERGY STAR PROGRAMS include a test procedure, certification (including presence in an on-line database) and a label.

A comprehensive review of energy labels and standards was recently published by Wiel and McMahon (Wiel and McMahon 2001) but did not explicitly deal with low power modes. In 2001, the IEA (International Energy Agency 2001) surveyed some of the international programs dealing exclusively with standby power. We compiled information on many of the world's energy efficiency programs and classified them by their treatment of standby, other low power modes, and active power. Selected programs that either have explicit policies regarding standby or represent a type of strategy are listed in Table 1 below. Most of these programs explicitly target standby (for a few products anyway), but others *implicitly* do not deal with it by ignoring low power modes' contribution to total energy use.

### Mandatory Certification Programs

**Brazil** has passed legislation requiring all consumer electronics to display their standby power use at the point of sale. The law is supposed to take effect in 2003 but no information has been issued regarding testing procedures or display guidelines. Brazil appears to be the only country implementing mandatory certification program targeting low power modes.

### Voluntary Certification Programs

**ENERGY STAR** ([www.energystar.gov](http://www.energystar.gov)) is the largest and best-known energy efficiency certification program in the world. Detailed information about ENERGY STAR is available on its website, including technical specifications and lists of qualifying products. In principle, the ENERGY STAR designation goes to only the top 25% (or about) of the products available, but the fraction of products that qualify varies with the product. For example, nearly all computer monitors and fax machines qualify but very few set-top boxes do. Table 1 distinguishes among three separate ENERGY STAR programs—those dealing with consumer electronics, office equipment, and appliances—because each targets different power modes.

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<sup>2</sup> In this paper we refer to three basic operating modes: On, Sleep, and Off. Low-power refers to the combination of Sleep and Off. Previous LBNL papers have used Low-power as a synonym for Sleep. The term "Standby" is now generally being recognized as a power level and not an operating mode. Most devices achieve their standby power use when Off, so we sometimes use Standby to refer to the Off mode.

The **ENERGY STAR consumer electronics** program established specifications for TVs, VCRs, and audio equipment. This program seeks to reduce standby power—the minimum power required—for these products. Australia and Canada participate in this program.

**Table 1. Programs dealing with low power modes.**

Program/Activity	Region	Covered Devices	Standby	Sleep Modes	Active Power
Energy Star consumer electronics/Certification	US, Australia, Canada, Taiwan	TVs, VCRs, set-top boxes, audio, etc.	Yes	No	No
Energy Star office equipment/Certification	US, Europe, Japan, Australia, Taiwan, Canada	Computers, monitors, printers, copiers, fax	No	Yes	No
Energy Star appliances/Certification	US, Canada	Refrigerators, washing machines, etc.	No*	No*	Yes
European Code of Conduct/Certification	Europe	TVs, VCRs, IRDs, low voltage power supplies	Yes	Yes	No
Australian Greenhouse Office/Certification	Australia/NZ	All	Yes	No	No
Chinese SETC/Certification	China	TVs	Yes	No	No
TCO/Certification	International, Sweden	Monitors	Yes	Yes	No
Blue Angel/Certification	Germany	Various	Yes	No	No
Group for Energy Efficient Appliances/Certification	Europe	Most consumer electronics and office equipment	Yes	Yes	Yes
Top Runner/ Mandatory	Japan	Office Equipment & Electronics	Yes	Yes	Yes
Appliance Standards Program/Mandatory	US	Major domestic appliances	No*	No*	Yes
Federal Energy Management Program (FEMP)/Purchasing specification	US	All plugged-in devices	Yes	No	No
International Electrotechnical Commission (IEC)/Test procedure	International	All plugged-in devices	Yes	No	No
Ministry of Energy, Brazil/Label	Brazil	Consumer electronics	Yes	No	No

\* Except refrigerators and freezers, which are measured for 24 hours

The **ENERGY STAR office equipment** program established specifications for computers, displays, printers, copiers, fax machines, and several other types of office equipment. This ENERGY STAR program focused on the device's "sleep" mode<sup>3</sup>. This is the oldest ENERGY STAR program and was established in the early 1990s. The goal was to reduce the number of hours that a device was "on" by establishing a new, "low power" mode and requiring ENERGY STAR –compliant devices to automatically switch into that mode after a period of inactivity. Different formulas are used to set maximum levels for the ENERGY STAR mode. In some cases, such as monitors, all units must comply with one level. Copiers and fax machines have several levels depending on the product's capacity. The ENERGY STAR level for computers depends on the rating of the computer's power supply.

<sup>3</sup> Copiers are an exception. The ASTM (and ENERGY STAR) test procedure includes measurements of "off" mode. Copiers differ from other electronic products because they sometimes keep a heater switched on, which can be responsible for substantial energy use.

Traditionally the ENERGY STAR office equipment program focused exclusively on sleep mode power consumption. ENERGY STAR staff are exploring new specifications that capture performance in all major modes (that is, off, sleep, and active). The first target is computer displays.

The ENERGY STAR office equipment program operates in the United States, Canada, Japan, Europe, Australia, and Taiwan.

The **ENERGY STAR appliance** program covers traditional white goods, including refrigerators, dishwashers, clothes washers, and air conditioners. Most of the selection criteria are based on the appliances' performance in the DOE test. Only the tests for refrigerators and freezers cover standby power (because they are 24-hour tests). For the remaining appliances, however, ENERGY STAR implicitly excludes standby and low power modes from its certification scheme.

The Department of Energy recently developed a revised test procedure for dishwashers to address a problem related to the performance of sensors. The test was revised at the same time to capture standby power use. The test has not yet been officially adopted in either the ENERGY STAR certification program or the mandatory energy efficiency standards for dishwashers.

Ceiling fans were recently added to the list of devices covered by ENERGY STAR. Many of the high-end units now include a remote control, which results in standby power use. The initial specifications covered only the efficiency in the active mode; however, the Tier 2 specification may include a 1-watt limit on standby power use.

**Group for Energy Efficient Appliances** (<http://www.efficient-appliances.org/home.htm>) The GEEA is a Europe-based energy efficiency labeling program designed to recognize the top 25% of products in their class. Information, specifications, and lists of qualifying products is available at GEEA covers many types of consumer electronics and office equipment, including some not yet covered by ENERGY STAR (such as wall packs). Qualifying products are eligible for a label.

GEEA is the first (and the only) program to include specifications for more than one low power mode. For example, the specification for audio products include maximum levels for "off-mode" and "standby-passive" power use. The specification for IRDs (Integrated Receiver Decoder – a high-end set-top box) includes maximum levels for three different modes. The specification for analog TVs also includes a minimum efficiency in the active mode.

The GEEA is used in Europe by eight countries. Over 1,600 products are listed in the GEEA database. It is not clear how the inconsistent specifications of GEEA and ENERGY STAR are reconciled for office equipment (both of which are recognized in Europe).

**European Code of Conduct** (<http://energyefficiency.jrc.cec.eu.int/>) The European Code of Conduct (with regard to energy efficient equipment) consists of several voluntary agreements with associations of manufacturers. In 1997, the European Commission negotiated an agreement with individual consumer electronic manufacturers and the EU trade association EACEM to reduce the standby levels of TVs and VCRs. A framework to reduce standby losses in all consumer electronic equipment was established in 1999. This prompted a specific Code of Conduct in 2000 to reduce standby losses in external power supplies. The specifications for external power supplies are shown in Table 2.

**Table 2. Code of Conduct for external power supplies**

	<i>No-Load Power Consumption</i>		
Rated Input Power	Phase 1 January 2001	Phase 2 January 2003	Phase 3 January 2005
> 0.3 W and < 15 W	1.0 W	0.75 W	0.30 W
> 15 W and < 50 W	1.0 W	0.75 W	0.50 W
> 50 W and < 75 W	1.0 W	0.75 W	0.75 W

About 15 manufacturers have signed this Code of Conduct, including some of the largest manufacturers of power supplies and consumer electronics. This Code appears to have had a significant impact on the market. A second Code of Conduct was established in 2000 for set-top boxes (Table 3) and a third Code of Conduct in 2002 dealing with audio equipment.

**Table 3. Code of Conduct specifications for cable, terrestrial, and satellite set-top boxes**

Mode	Stand-Alone Box 2003–2004	Box Built Into TV 2005–2006
Off-mode	1.0 W	1.0 W
standby passive (where specified)	6.0 W	3.0 W
standby active	9.0 W	10.0 W

Additional power is allowed in the standby active mode when the box has more features. The allowances are listed in Table 4. However, there is a limit of 15 W (or 16 W if built into a TV) regardless of the additional features.

**Table 4. Power allowances for additional features in a set-top box.**

Feature	Indicative additional maximum power consumption for additional features
Internal hard disk drive	1.1 W
IEEE1394 interface	0.8 W
Ethernet interface 100Mbit	0.4 W
Wireless interface	0.7 W
Serial USB interface	0.3 W
Home automation interface	0.4 W
ADSL modem	2.0 W
Extra cable modem	0.7 W
Additional tuner	0.7 W
Additional LNB feed	1.3 W

About seven manufacturers have signed this Code, but it is not clear what fraction of their products will comply today or will comply in the future. Additional meetings are underway to clarify the Code.

**Australian Greenhouse Office** (<http://www.greenhouse.gov.au>). The Australian Greenhouse Office (AGO) is currently working with its stakeholders to reduce standby power use in all products. These stakeholders endorsed a one-watt plan in 2000, and the AGO is evaluating plans to achieve that goal. Australia is already an ENERGY STAR partner for both office equipment and consumer electronics, so most of the major devices are already covered by voluntary programs.

**The State Economic and Trade Commission** (China) (<http://www.setc.gov.cn>). The SETC began negotiating with Chinese TV manufacturers in 2001 to reduce standby to 3 W (the current ENERGY STAR TV level). This is a voluntary target but it is generally understood that a mandatory standard will be established if compliance is low. Other appliances are also being considered.

**TCO** (<http://www.tcodevelopment.com>) is a Swedish labeling program whose principal goal is to establish ergonomic and safety criteria for various equipment, including computers, monitors, and other office equipment. It has included energy efficiency requirements for a few products—notably monitors—since 1995. It now recommends that monitors be able to achieve a sleep-mode power consumption of no greater than 5 W. Recommended levels for other products generally follow ENERGY STAR specifications.

**Blue Angel** (<http://www.blauer-engel.de>) is a German environmental labeling scheme also known as “Blauer Engel.” It is operated by a consortium of four German government and non-government agencies. Blue Angel has created environmental specifications for hundreds of products, from automobile tires to zinc-air batteries. Specifications for office equipment and consumer electronics include energy efficiency criteria similar to those of ENERGY STAR or GEEA. It also requires the standby power consumption to be listed in the product’s manual. Blue Angel requires TVs to have a hard-off switch (to zero power) on the front of the machine.

There are several other eco-labeling schemes operating around the world, including Nordic Swan, Greenseal, and the EU Ecolabel. Each has a unique orientation and many include energy efficiency specifications, though typically borrowed from ENERGY STAR or some other source.

## **Mandatory Efficiency Standards**

**TopRunner** (<http://www.eccj.or.jp/>) is the name of the Japanese mandatory energy efficiency program. It is operated by the Japanese Ministry for Economic Trade and Industry (METI). TopRunner covers automobiles, appliances, office equipment, and consumer electronics. Some of the test procedures used by TopRunner capture standby and low power modes. For example, the TV test includes all major operating modes. Efficiency specifications for other appliances, such as room air conditioners, capture energy use and efficiency in only the active mode.

The **United States Appliance Efficiency Program** (<http://www.eren.doe.gov/buildings>) is administered by the U.S. Department of Energy. These standards cover consumer refrigerators, washing machines, water heaters, clothes washers, air conditioners, heat pumps, and a few other appliances. With the exception of refrigerators and freezers (and perhaps soon, dishwashers), none of the standards cover standby or any other low power modes. Modifications of the test procedures to include standby power (a necessary precursor to modifications of the standards) are not considered a high priority at DOE but may be implemented gradually as the standard for each appliance is updated.

**The Federal Energy Management Program** (<http://www.eren.doe.gov/femp/>) FEMP was recently charged by President Bush to implement a plan to purchase low-standby products. (It is already charged to purchase ENERGY STAR products.). In 2002, FEMP issued purchasing requirements for major types of office equipment and consumer electronics. In the case of consumer electronics, the federal purchasing requirements specify a lower standby level than ENERGY STAR. The current and proposed future specifications are shown in the Table 5.

**Table 5. FEMP standby specifications (as of August 1, 2002)**

<b>Product Category</b>	<b>Recommended Standby Level (Watts)</b>	<b>Effective Date</b>
<b>Audio/Video Products</b>		
TV	1	January 2002
VCR	2	January 2002
TV/VCR Combo	3	January 2002
Audio Product	2	January 2002
<b>Office Equipment</b>		
Desktop Computer	3	July 2002
	2	July 2003
Laptop Computer	1	July 2002
Computer Monitor	2	July 2002
	1	July 2003
Printer	1	July 2002
Copier	1	July 2002
Fax and Printer/Fax Combo	4	July 2002
	2	July 2003

FEMP expects to issue further requirements for appliances and other equipment in 2002 and 2003.

### **Energy Test Procedures**

The International Electrotechnical Commission (IEC) established an *ad hoc* committee to develop a test procedure for standby power, principally for use in testing white goods. The committee charged to develop the procedure nevertheless had representatives from manufacturers of consumer electronics. A “Committee Draft” was issued in July 2002. (International Electrotechnical Commission 2002). Its key aspects are:

- The test is generally aimed products that can be plugged into the mains but can also be used for hard-wired products.
- “Standby Power” is defined to be the minimum power use of device while connected to the mains, irrespective of its operational mode.
- Re-chargeable devices are treated as a unique group, whose standby power is measured while the separable device is removed from the charging station.

This test is similar in key aspects to that proposed by FEMP several months earlier. The Committee Draft must be reviewed by member countries, revised, and approved before it is officially recognized. However, EPA will probably begin referencing it in its test ENERGY STAR specifications soon.

Many of the tests for other low-power modes originated with ENERGY STAR . These have been developed on an *ad hoc* basis. As a result, they are inconsistent with respect to terminology and conditions.

## Corporate Programs

Many multinational firms build and trade products with low power modes. Some have recognized the international trend to reduce standby power (and, to a lesser extent, sleep mode) and made it part of overall corporate strategies. For example, the Sony Corporation (Sony Corporation 2002) established a corporate goal to reduce standby to below 1 W for all its products. This goal has not been fully achieved (see Table 6) and the company admits that it has had difficulty achieving this goal in all its products.

**Table 6. Lowest standby power levels achieved by Sony products (source: Sony Corporation).**

Category	Standby Power Consumption (W)	Operating Power Consumption (W)
Car audio	0.02	13
Handheld computer	0.1	0.37
Digital still camera	0.4	1.9
Digital camcorder	0.2	3.4
Notebook PC	1.8	34
Color television	0.07	64
Computer CRT display	3	115
Color LCD for computer	3	48
LCD video projector	5	190
MD system	0.3	10
Personal audio system	0.2	70
DVD player	0.11	11
Video cassette recorder	1.8	18
Mobile phone	0.009	0.67

This table shows that very low standby levels have already been attained for some products (although these may not be available in the United States). However, these are premium products for which consumers must pay considerably above the typical prices. Sony's standby performance lags other manufacturers for some products, such as LCD displays. This probably reflects the product's position in the product cycle rather than any particular obstacle.

The ENERGY STAR specifications for sleep mode power use in office equipment and the Executive Order to reduce standby power also encouraged companies to investigate new techniques to save energy. There is little documentation of these internal efforts though anecdotal evidence suggests that some companies made important investments to achieve these targets.

Conserving energy in low power modes is typically a secondary corporate goal (and sometimes not even a motivation at all). Other goals, such as reduced weight, greater durability and product life, and extended battery life, are more likely drivers.

## **Proposed Programs**

Several programs have been proposed to address low power modes. These are briefly described below:

*Mandatory maximum levels for standby power use in certain products or components.* Legislation in the United States Congress includes proposals to limit standby power use in certain products. This is still being negotiated (summer 2002). Similar legislation is also being explored in California.

*“Vampire” buy-down program.* This program was originally proposed by Arthur Rosenfeld in 1999. The aim is to provide a financial incentive to manufacturers to use high-efficiency external power supplies. The rebates would go to manufacturers of the whole product (that is, cell phone plus power supply) rather than to consumers so as to reduce the transactions cost and maximize the incentive to manufacturers. This proposal was explored in detail by Noah Horowitz (NRDC) and Chris Calwell and Travis Reeder (Ecos Consulting) in 2002.

*Minimum efficiency standards for power supplies.* After considerable research into the power situation (Calwell and Reeder 2002), Chris Calwell and Travis Reader (Ecos Consulting) and Noah Horowitz (NRDC) proposed establishing minimum efficiency standards for power supplies (both external and internal).

*Limiting hard-wired standby power use in new homes.* Building codes and general practice are causing more use of hard-wired devices with standby power use (smoke alarms, GFCIs, thermostats, HVAC components, security systems, etc.) Together, these can easily add 40 W to a home’s standby power use. In 2001, Alan Meier proposed that the CEC first measure these devices and then, if warranted, establish minimum efficiency standards.

*Establish a common communications protocol for cable service providers.* Interested groups need to establish a way for set-top boxes to effectively power manage. This can only be accomplished if cable service providers agree on communications protocols that permit the boxes to go to sleep when not in active use and wake up on specific signals.

## **Conclusions Regarding Programs Targeting Standby and Low Power Modes**

A wide array of programs is already in place to deal with standby power and low power modes. These exist all over the world and are both voluntary and mandatory. Each program has unique features but there are some common aspects. For example, nearly all programs rely on ENERGY STAR specifications for sleep modes. Few programs, however, have systematically approached *all* low power modes; either they target standby or sleep modes but not both. The first step is to create energy test procedures that cover the entire duty cycle. Ideally, these test procedures should be internationally harmonized.

No group has dealt with low power modes in white goods. This is a relatively small aggregate load today but will grow rapidly in the next few years. An effective program must first evaluate the needs for white goods, especially in anticipation of network connectivity, and establishing appropriate test procedures.

It is also important to design programs that recognize the low savings per product and ensure that the transactions costs are as low as possible. Labeling programs for only standby or only sleep may not be cost effective, and can confuse the consumer. In some cases, the products may be so small that there is no place to display the label or required information.



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